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A HIGH ARCTIC SUMMER EXPEDITION

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ABSTRACT

The author participated in an international palaeontological expedition to the High Arctic from July 6 to August 1, 1989. This account of the expedition includes general observations on such subjects as clothing, tents, drinking water, emergency fuel, terrain, visual perception, mosquitoes, animals, river crossings, etc. An extended trial of a prototype cold weather clothing system was carried out in conjunction with daily activities. Measurements of the effect of the low-angle sunshine on the temperature of an absorbing vertical cylinder confirm that solar radiation is an important factor in the sensation of "wet-cold".

RESUME

L'auteur a participé dans une excursion paléontologique internationale dans le grand arctique à partir du 6 juillet au 1er d'août 1989. L'exposé qui suit comprend des observations générales au sujet de vêtements, de tentes, d'eau potable, d'essence d'urgence, du terrain, de la perception visuelle, des moustiques, des animaux, des traversées de rivières, etc. L'évaluation prolongée d'un système prototype de vêtements à l'épreuve du froid fut complété durant les activités quotidiennes. Suivant l'étude de l'effet du bas angle d'ensoleillement sur la température d'un cylindre vertical absorbant il fut confirmé que la radiation solaire est un facteur important à la sensation du "froid-humide".

EXECUTIVE SUMMARY

The author accompanied the 1989 High Arctic Expedition of the Canada-China Dinosaur Project to Bylot and Ellesmere Islands. This paper is a narrative of that expedition. It concentrates on the performance of the clothing and equipment being trialled, measurements of the effect of the low-angle sun on comfort, and on subjective impressions of the arctic summer in these locations. Included are general observations on drinking water, emergency fuel, terrain, visual perception, mosquitoes, wild animals, river crossings, etc. The value of first-hand experience of difficult environments is emphasized.

Scientific field parties in the High Arctic are supported by the Polar Continental Shelf Project (PCSP) of Energy Mines and Resources Canada. The network of field parties spread throughout the Arctic Islands reports to Resolute twice daily, and could therefore be used to gather information on possible air or marine movements in the area. The corporate experience of PCSP concerning arctic operations is vast. A compilation of information such as the locations of commonly used landing places for small aircraft could be valuable for defence purposes.

The Arctic Research Institute in Pond Inlet is also a potentially useful facility for small DND operations. In addition, its founder, Hermann Steltner could be a useful consultant in planning operations in the area.

The prototype clothing system was worn in cold wet conditions for an extended period. Some minor problems were noted, both in design and in the concept of use. Problems were also noted in connection with footwear.

Thermometers were set up at camp locations on Bylot Island and Ellesmere Island to measure the heating effect of the low angle sunshine on a vertical surface approximating a face randomly oriented with respect to the Sun. The results support the suggestion that sunshine is an important factor in thermal comfort at temperatures around freezing and that the "wet-cold" sensation may result when cloud cover and wind reduce the effects of solar heating.

INTRODUCTION

The 1989 High Arctic Expedition of the Canada-China Dinosaur Project travelled to Bylot and Ellesmere Islands during the month of July. Bylot Island was a focus of interest for the Project because of the recent discovery of dinosaur fossils by a geological field party (1); Ellesmere Island was included because of historical references to the existence of large fossilized bones in an area of the island south of Bay Fiord (2). The narrative section of this paper emphasises the interactions of daily activities, weather and clothing, but also includes subjective impressions of the arctic summer in these locations. The performance of the equipment being trialled and results of measurements of the effect of the low-angle sun on comfort are summarized separately.

The expedition was organized by the Palaeobiology Division of the National Museum of Nature in Ottawa and was led by Dr. Dale Russell. Also from the Museum were Richard Day and Clayton Kennedy. Dr. Phillip Currie of the Tyrrell Museum of Palaeontology in Drumheller, Alberta and Dr. Dong Zhiming of the Institute of Vertebrate Palaeontology and Palaeoanthropology in Beijing, China also participated. The Bylot .sland portion was filmed and photographed by Andreas Poulsson, Allan Bibby and Mike Todor.

NARRATIVE

POND INLET AND BYLOT ISLAND

The July 6th flight from Ottawa to Pond Inlet stopped for a couple of hours in Iqaluit. I used the opportunity to visit the Iqaluit hospital for an assessment of a painful injury which had occurred that morning. Although the X-ray of my right foot revealed no broken bones, I was advised to stay off it for a week or so. This was of course not possible, but for the next two weeks or so I had to limit my work rate and range to some extent. This injury is probably partly to blame for the preoccupation with footwear which the reader may detect in the following.

From Iqaluit we flew northeast over the mountains of Auyuittuq National Park where a group from DREO had carried out a clothing trial in August 1988. The stop at Broughton Island, at the end of Pangnirtung Pass lasted only five minutes. Another stop was scheduled at Clyde River but fog made the landing impossible. Although the sea-ice was covered by low cloud which invaded low coastal areas, the uplands were in bright sunshine. Obviously, weather observations from coastal airfields do not necessarily reflect the flying conditions over the whole area.

We stayed overnight at the Arctic Research Institute in Pond Inlet. The Institute is potentially a useful facility for small DND operations. The base in Pond Inlet consists of a laboratory

building (which we used as a dormitory), a shop, a residence building with accommodation for four and another residence for the staff. Equipment available for researchers ranges from komatiks to computers. The Institute also has small outlying stations in the area. Its founder, Hermann Steltner, is an engineer, oceanographer and former soldier. He is also a valuable source of local information. Meteorology has been one of his special interests. He has developed his own system for forecasting flying conditions over a large area which, he claims, has proven to be very accurate. He also claims expertise in estimating the date of breakup and freeze-up and so could be a useful consultant in planning operations in the area.

The village of Pond Inlet contains two retail stores, the Bay and the Co-Op store. The only large truck in town, owned by the Bay, transported our equipment. The Bay store is easily identifiable but the Co-Op store, which is near the creek, is only identified by its colourful flag.

Although Pond Inlet has a fine sandy beach, the picturesque two-metre thick grounded ice floes banished any thoughts of swimming. Eclipse Sound was still a solid sheet of ice except for the shore leads (lanes of open water along the shore). Despite the bright sunshine, the breeze off the Sound was cold. Across Eclipse Sound, Bylot Island provided a spectacular backdrop of glaciers and mountains, capped by a small persistent cloud. Low lands in the southwest and many of the sea-cliffs are nesting areas for millions of birds. The island is an officially protected bird sanctuary and so off limits to large military exercises in summer.

We crossed to the island by helicopter (chartered by PCSP) and set up our camp on the beach at a traditional Inuit camp site known as Iglookishak (Fig. 1). The site was at the mouth of a small river, directly across the Sound from Pond Inlet and a few kilometres west of the terminus of the Sermilik Glacier. A dark mountain beyond the glacier dominated the view. There is one small rectangular wooden building at the site constructed in a manner reminiscent of a snow house with a sleeping platform at the back, benches along the sides and a low doorway. The walls and ceiling were double, windproofed with old magazine pages on the inner walls. The 10 cm space between the walls was insulated with Cassiope tetragona, an arctic heather with small, white, bell-shaped flowers (Fig. 2). The compact leaves make the stems appear to be square in cross-section. Stefansson (3) recommended this plant as fuel where there was no driftwood or where the willows were not abundant.

Each person had his own small two-man tent. Two Logan tents, supplied by the PCSP, were also set up: one as a cook tent, containing all of the supplies, and the other as a tent in which we ate and discussed the day's events out of the wind and weather.

FIGURE 1. Tents at Iglookishak, Bylot Island. The posts for the bear alarm are in the foreground. The Logan tents and radio mast on the right.

FIGURE 2. Cassiope tetragona, an arctic heather which may be used as fuel.

Folding chairs added greatly to camp comfort and efficiency. The second Logan tent also housed the radio, an SBX 11, with which Richard Day contacted the PCSP base in Resolute twice daily. A Coleman stove was used for cooking and a large catalytic heater was sometimes used for warmth for temperatures in July at these latitudes are often around freezing.

Camping on an arctic beach is not recommended, for polar bears patrol the beaches hunting for seals in the shore lead. At this location we had the added attractant of caches of meat that had been left by the Inuit in the spring. However, inland sites were either wet or on the side of a hill or mountain. A simple trip-wire alarm system added some security during sleeping hours. There were several shotguns in the camp. A 12-gauge, pump-action shotgun with rifle sights and a large magazine is recommended by the North West Territories Department of Renewable Resources for deterring or, as a last resort, stopping, a bear attack (4,5). Deterrence involves the use of cracker shells and plastic rounds designed for the purpose. Interested readers should refer directly to the referenced sources for details. I kept the magazine loaded with slugs except for the last round which was 00 buckshot. One space was left in the magazine so that a scare cartridge or a plastic round carried in a pocket could be added if the situation allowed. A shotgun was carried by each group when away from camp.

Camera tripods were set up a short distance from the tents to support two dial thermometers tapped into cylinders of solid aluminum. One cylinder was covered with shiny aluminum tape and the other was painted flat black to determine the effect of solar radiation on the temperature of a vertical surface. The first morning, at 9 a.m., the bright thermometer registered 9 °C in sunshine while the black thermometer registered 19.5 °C. The bright cylinder, despite its apparently high reflectivity, consistently read 5 °C higher than the dry bulb temperature in bright sunshine when the wind was calm or very light. As the air temperature was about 4 °C, the sunshine had warmed the black vertical cylinder to approximately fifteen degrees above the air temperature. That evening the black and the bright thermometers read 6 °C and 5 °C respectively in overcast conditions. It was noticeably less comfortable without the sunshine.

That first afternoon we climbed the range of hills fronting the beach to explore the far side for fragments of dinosaur bone. Although from Pond Inlet this range of hills had seemed insignificant compared to the mountains behind, they rose to a maximum altitude of around 250 metres, about the height of an eighty-storey building. We climbed up and down the steep sides of these sandstone hills for four days. Prospecting for fossils involved a pattern of walking slowly along the side of the hill, dropping down a couple of metres and walking back parallel to the original track. Because of my inexperience, the search was at first very mentally fatiguing because I had to consciously examine

every stone and pebble on the surface. Later, after becoming familiar with the shapes and colours of fossils fragments, I could simply scan a small area for objects of the right colour and shape without being aware of most of the ordinary stones. The professional fossil hunters had a highly developed ability to selectively perceive fossil fragments. Selective perception is employed in everyday life. A familiar example would be finding a particular book in a large bookcase. Knowing what the book looks like helps you find it for you can simply scan the shelves for the right colour and shape without having to read the title on the spine of each book or even be aware of their shapes and colours. Unfortunately, if your mental image of the book is wrong, the perceptual filter makes it invisible.

While having lunch at the stream at the base of the island side of the dinosaur hills, I tested Stefansson's advice regarding the usefulness of Cassiope tetragona. The lower parts of the plant were often dry and brown and burned very nicely. Even the green parts burned. A small can of water was boiled with a handful of these. The tributary brooks derived their water from lingering snowdrifts many of which were almost black on the surface. Despite this, the water in the streams was clear, cold and drinkable. The land was pristine with green turf, boulders, fields of flowers and sparkling brooks.

The next day, July 9, was cool, windy and rainy: poor weather for prospecting. When the sandy hills were wet, they were darker coloured. The fossils were mostly dark in colour and were more difficult to see against this background. I set off up the beach to try out the prototype cold weather clothing (Table 1) in what could only be described as miserable weather. The air temperature was 2 °C in driving rain at the start. I wore the jacket and trousers with combat boots and the Helly-Hansen pile jacket liner and Norwegian Army shirt. I wore a wide-brimmed hat, for the first and only time. The malleable wire around the opening of the jacket hood kept the hood rolled into a collar, and kept it tight against my neck to keep out the rain. After this I wore a peaked cap, so that I could keep the hood up to better protect my face from cold winds. The rain completely wetted the outside of my clothing but did not penetrate at any point.

I walked slowly, looking for fossils, sometimes climbing a few metres up the hillside and working my way down in a search pattern. I found only one small, light-coloured fossil bone during the four-hour excursion, but it was the first bone found on the seaward side of the range of hills. The sand stuck to my wet clothing, gloves and the mechanisms of the shotgun. Cleaning sand out of the shotgun became a nightly ritual.

A narrow gully at the end of the fossil bearing formation opened to a coulee filled with Cassiope tetragona, a pleasant place for lunch despite the weather. A lightweight but heavy duty "Space

TABLE I

Major Element of the Clothing System

On the upper body:	
a. Norwegian Army shirt	Knitted cotton pullover with a high neck and short zipper. Inner surface terry looped.
b. Pile liner with hood	Polyester pile, 5mm. Zippered closure. Nylon wear patches and pockets. Made by Helly Hansen to our specifications.
c. Combat jacket	Consultex Commander nylon outer shell, coated with Dermoflex. Has hood and a light comfort lining.
d. Outer parka	Consultex Commander nylon outer shell, coated with Dermoflex. Insulated with 3.5 cm of PolarGuard, a continuous filament polyester batting. Nylon taffeta lining.
On the lower body:	
a. Combat trousers	Consultex Commander nylon outer shell, coated with Dermoflex.
b. Combat boots	NSN 8430-21-857-9098 Upper and lining of glutaraldehyde retanned chrome leather (silicone treated) and combination tanned leather insole. Nitrile rubber sole and heel. Three ply plastic (Saran?) mesh insole covered with knitted nylon. Standard wool and nylon work socks.

Blanket", reflective on one side and olive green on the other became a wind break and kept the rain off during lunch. I noticed that after sitting a while I began to feel moisture on my skin, particularly the legs. This clammy sensation went away after I started walking, indicating that significant moisture may be transferring by bellows ventilation effects in this system. I had probably been sweating during the climb, but the movement of air in the clothing had allowed the sweat to evaporate. When I sat down, this extra air motion ceased and the sweat accumulated.

Rain and snow alternated during the final two hours. While it was snowing, the outside of my clothing started to dry in the wind. Although my work rate was not very high and I did not suffer from overheating or overcooling to any significant extent I was grateful to get out of the wind back at the camp. I returned in time to join the others in a bizarre snack of smoked oysters, picking them out of the can with seventy-million-year-old shark teeth.

It was a relief to get back to my own small tent and remove my combat boots for neither my feet nor my boots were completely broken-in. The white adhesive tape that I used to bind the injured foot was also used to protect the areas of my feet where my boots rubbed. The heel of the combat boot seemed designed to wear the heel of the foot and, as I discovered after the tape was gone, does so very well.

My tent was dome-shaped with an "expedition" fly which reached the ground all around the tent and made a small vestibule in front. The outside was blue and yellow and translucent, the inner tent more or less white. Sunshine had a big effect on the temperature in this small tent. A net under the highest point of the dome which held my glasses at night and things which needed to dry also held a thermometer. It registered 12 °C a foot or so below the ceiling. After the sun came out the temperature in the tent rose to 23 °C; outside it was still at or near the freezing point. At 11:30 p.m. in the shadow of the mountains the tent had cooled to 4 °C. Next morning the tent was 24 °C in sunshine and at 2 p.m. it had warmed to an impressive 37 °C. The black thermometer read 19 °C, although the air temperature was only 6 °C. Clouds poured over the mountains an hour later and it was soon cold again. At 7:30 p.m. the tent was down to 10 °C and the black thermometer to 5 °C.

Several interesting finds were made, including the bones of hadrosaurs (duck-billed dinosaurs), plesiosaurs and huge, toothed birds. We returned to Pond Inlet on July 11.

RESOLUTE AND ELLESMERE ISLAND

Weather kept us in Pond Inlet for a day. The flight to Resolute on July 13 in a PCSP Twin Otter took three hours. Because we were flying at a moderate altitude under the overcast, we had a good look at the Northwest Passage and its wildlife: seals, walrus,

belugas and narwhals. In my several trips north I had somehow managed to miss Resolute. As we landed, the word "bleak" sprang immediately to mind. Grey stratus hung over barren hills which bordered a plain of sterile gravel. Subsequent experience did little to erase this impression. On the other hand, the PCSP base was an impressive facility. Scientists of all disciplines pass through the PCSP base all summer long. An extraordinary education in arctic science might be obtained from dining room conversations over a short period of time.

Our first attempt to reach the area south of Bay Fiord on Ellesmere Island was forced back by cloud over Baumann Fiord, a few minutes short of the goal. The second attempt, on July 14 was successful. Although it was mostly overcast and drizzling cold rain at Resolute, a recent satellite photo showed clearing in the landing area. Our pilot, Duncan, did not hold out much hope of being able to land us close to the area we wished to search. He said that it had been the coolest, wettest summer in the High Arctic that anyone could remember and that almost every place that was flat enough to land was wet and soft. The June rainfall had been fifty percent higher than normal but the temperature had actually been a degree higher than average (6). The extra cloudiness had probably made it seem much cooler. We had hoped to reach Amund Ringnes Island as well but, according to Duncan, the wet season had turned it into a "swamp".

Wellington Channel, which had appeared wide open when seen from the south on the flight to Resolute from Pond Inlet, proved to be a solid sheet of ice. Open water was seen in the area of Hells Gate but to the north, the central part of the channel between Graham and Ellesmere Islands was a solid sheet of ice with very little ridging. There were large areas of what appeared to be blue ice with scattered white areas, possibly blue lakes of melt water on top of the ice cover. Farther north, seal holes became more common and as we approached the Bjorne Peninsula a large lead (crack) appeared below the aircraft. In crossing such ice in the melt season, it may be advisable to follow leads when possible for the melt water drains into the sea along the crack leaving drier ice in its vicinity. The melt water channels might present some problems, however. Seal holes, which also drain the ice, were often surrounded by large, white areas in the blue lakes.

When we reached the area between Bay and Trold Fiords, our pilot examined several potential landing areas before heading for a known "strip" at the mouth of the Fossil Forest River on Strathcona Fiord. Duncan examined the landing site carefully before landing, making several passes and wild manoeuvres that made my head spin. PCSP has taken hundreds of field parties into remote areas over the years. From experience, the pilots of the aircraft chartered by PCSP know where to find the best places to land throughout the Arctic Islands. A compilation of this knowledge could be a valuable reference for northern defence and northern

development. The Mapping and Charting Establishment (MCE) of DND has been very active in recent years throughout the High Arctic and could likely contribute much to such a reference. While examining this area we discovered a DND bench mark and a large white and red fabric cross deployed, I presume, by MCE surveyors engaged in the small scale mapping program.

Our wait for a helicopter at Strathcona Fiord was enlivened by a visit from a large white animal. Seen at a distance, its colour and odd gait identified it as it a polar bear. A shot in the air discouraged it from coming closer. When we examined the beach we found only the tracks of a large wolf. Later, after I had left in the helicopter, the animal approached those left behind quite closely and unexpectedly. It proved to be a large white wolf with an injured and swollen hind paw that had forced it into an unnatural gait. Although a bear is much larger than a wolf, size is impossible to judge without distance cues.

I experienced this problem of judging size and distance most vividly at Rea Point on Melville Island several years before. Brad Cain and I climbed a hill near the Polar Gas complex to have a look at a telephone pole we could see on the top because it seemed oddly out of place. There was an enormous rock half way up the hill where I hoped to get out of the wind for a bit, for it was early March and extremely cold. The rock, however, was not as far away as I had thought and not as big, barely knee-high. The hill was a lot smaller, too. Seen from the rock, the "telephone pole" transformed into a fence post. As we continued to climb, the side of the hill came between us and the fence post. On top we were surprised to find that the "fence post" was in reality a one-inch diameter iron pipe protruding a foot or so above the snow. Such illusions of scale are common. A small piece of ice can be mistaken for a distant upturned floe the size of a house, a lemming can be mistaken for a barren ground grizzly bear and a walrus for a glaciated island. The day after making camp on Ellesmere Island, a pair of snowy owls bluff-charging in defence of their nest were briefly mistaken for polar bears.

Our camp was established by helicopter on the west shore of a tiny lake at approximately 78° 48' N, 84° W. The lake is situated in hills east of an unnamed, wide valley which runs roughly northwest. In the mile-wide floor of this valley is a braided river which varied considerably in size from day to day depending on the weather, wider on sunny days when it flowed over a large fraction of the valley floor. Only a small part of our little lake was ice-free. The ice cover appeared to be candled but did not break easily into prismatic pieces as expected. It would probably have been possible to walk on the ice but an experiment was not thought worth the risk of an ice water bath. Pieces which had broken off the edges of the ice cover made noises like wind-chimes when the waves jostled them together; sometimes the sound recalled a distant memory of early mornings in the days of milkmen and glass

milk bottles. The water in the lake was drinkable despite the proximity of units of the Kanguk Formation. This sedimentary rock formation is largely dark shale or mudstone which is very acidic and in some places smells sulphurous.

The trip wire alarm system was again deployed around the sleeping tents, although polar bears were not likely to visit this inland site. The fence had two strands of insulated wire on wooden dowels pushed into the ground. The wire formed a circuit of short segments connected in series by jacks. These separated when the wire was stressed and caused an alarm to sound. Two alkaline lantern batteries connected in series provided 12 volts to power the fence. Although a fence can be designed to run on a 9 volt battery, more capacity might be adviseable because low temperatures effect batteries adversely. This particular fence had been made for use with a lead-acid battery on a snowmobile. We walked through it several times without seeing it despite the fact that the wires were red. Bits of orange flagging tape were added to the wires to increase their visibility. The circuit was connected before I took my boots off at night and disconnected when I put them on again in the morning. Once in my tent I could not be sure of not falling asleep and once did so between boots.

A pair of slip-on shoes for wear around the camp would have been useful to avoid the necessity of having to lace up boots before going out of the tent. Dale Russell used a pair of old bedroom slippers for this purpose. The mesh insole of one of my combat boots, almost new at the start of the expedition, collapsed to the point that I could feel the boot sole on the ball of my foot. As this became painful, I used felt insoles. A lot of walking was planned, for the area we were to examine was approximately 400 square kilometres, about the same size as the city of Ottawa. This was done on foot over the next two weeks. Of course not all of the area was prospected, only those places where erosion had exposed rock of the right age. It involved much hill climbing, with the result that I became more fit and lean than at any time in the last fifteen years. I walked as far as 20 kilometres in a day in hilly and boggy terrain, not including the distances walked in search patterns on steep hillsides. Towards the end of this two week period, Clayton Kennedy gave me a Blister Kit, made by Spenco Medical Products, which made walking less painful. I had been using bandaids and "gun tape" after losing my first aid tape. Although I was not then aware that anyone had ever died from blisters (7), my discomfort convinced me that it was a possibility. Hygiene was difficult. The other members of the expedition had the foresight to bring wash basins which they used in their tents. I had been making do with a plastic cup given to me by the airline on the way to Pond Inlet.

July 16 was a sunny day which felt very warm. Before leaving camp I noted a black thermometer temperature of 21 °C and a bright thermometer temperature of 12.5 °C at 8 a.m. Resolute time. Some

of the paint had come off the black thermometer when we moved so I had covered it with black "gaffer tape" scrounged from the camera crew before they left us in Pond Inlet. I have since found that the tape and the black paint absorb solar energy to approximately the same degree.

We began to examine the slopes of the east wall of the big valley working south from our camp, past the point where the big valley is joined by a large river coming from the south. A party of Norwegians led by Otto Sverdrup had travelled down this tributary valley in 1901, discovering our big valley and following it to the sea. In early afternoon, I decided to cross the river to see if I could reach this tributary valley and on the way check out some gravel benches on the far side of the river. From the top of the high cliff on which I stood (Fig. 3), they looked like potential landing places. While looking for the least exciting way down the steep slope to the river, I climbed up and over the valley side to come almost face to face with a solitary bull muskox. He was as surprised as I was and fortunately decided to thunder off in a cloud of dust in another direction. He stopped on the edge of the cliff and turned to face me with his head lowered. These impressive animals might be dangerous if surprised, especially if they have no alternative but to charge. Since this one now had no options left, the urge to get a better photograph was successfully resisted.

The water in the river was full of sediment. Water from melting glaciers is often charged with rock flour which is noticeably gritty and "is one of the finest laxatives known to man" (8). Although there were no glaciers in the immediate vicinity, I did not think it adviseable to experiment. I had only a little trouble fording this river which was wide and composed of many braided channels and bars. A straight course was impossible for the channels varied in depth. I could not stand in water more than 60 cm deep because the current would have swept me off of my feet. It was therefore necessary to find a sufficiently shallow or low velocity section of each channel, unless I wanted to swim. Fluid dynamics suggested that the widest part of each channel might be the best and this usually proved to be true. By the time I reached the other side, both of my feet were wet. I had worn a waterproof Goretex sock over my normal wool socks on one foot but the water had come in the top which had a simple velcro closure. I switched to a dry pair of socks and insoles and tied the wet socks onto the the pack to dry in the bright sunshine.

The first gravel bench was long and flat, dry on the surface but just too soft I thought, to drive a car on with confidence and so probably not very good for an aircraft. The smaller bench was firmer, with a higher gravel content but it had a couple of small frost cracks which might roughen the landing. It was about

FIGURE 3. Richard Day on the cliff over looking the wide valley and braided river. Photograph courtesy Richard Day.

250 metres long, according to notes I made after returning to camp. Although the Twin Otter seemed to need only about 100 metres in the wind that had been blowing down Strathcona Fiord, a bigger safety factor might be appreciated by the pilots. The Strathcona landing area was about 400 metres long, although the best part of it was only about 250 metres in length.

After encountering very deep soft mud near the drifts melting on the northeast-facing side of the river, I decided to recross. North-facing sides of valleys and ravines tended to be more difficult to walk at this time of year because of the mud created by the snowdrifts that linger on the more shaded valley wall. Also, heads of vegetation, which we called "mud heads" and which are difficult and somewhat hazardous to walk on, were more often encountered on north-facing sides (Fig. 4). The river was up from what it had been when I first crossed it. Fist-sized rocks on the bottom rolled in the current when dislodged by my feet. I spent many minutes going back and forth finding the shallowest places to cross each of the many channels, looking for wide areas and trying to find places where the velocity was lowest. In one place, it was necessary to cut through a narrow bar on the outside of a curve to divert part of the stream and reduce the flow volume and depth where I had to cross. It was a good test of two designs for waterproof socks, for on this crossing I wore a stretch Goretex sock on one foot and the sock with the velcro closure on the other. The foot wearing a stretch Goretex sock stayed dry. I think the difference was largely due to the closure around the top of the sock which is elastic and fits tightly and smoothly to keep the water out. I had a pair of these, but could only wear one because it put pressure on the injury. The air temperature, estimated from the bright thermometer, was about 9 °C on return to camp at 6 p.m. All day I had worn only the Norwegian shirt and the trousers of the clothing system and was often too warm. I had a pair of khaki trousers, made of heavy cotton, which I afterwards wore on sunny days with little wind in preference to the coated trousers.

The warm weather continued all night and through the next morning. Although it was overcast with light breezes the air temperature was about the same, around 9 °C. I started the day with my jacket and the liner but soon stripped down to the shirt. It felt cool but not cold and the mosquitoes were out in force, the price of the previous day's warmth. These were the first mosquitoes seen. Although numerous, they were not voracious and seemed more interested in finding a place to warm their feet. As for my feet, the combat boots were still wet so I wore a pair of lightweight (Vasque) hiking boots using mesh insoles rather than the closed-cell foam with which they were supplied for the foam does not absorb sweat. Until now, my right foot had been too swollen to wear these boots; it still did not allow the use of a felt insole. July 18 it rained unusually hard for the Arctic Islands or so I was told. The temperature was still about 9 °C and although it did not feel nearly as warm as it had at this

FIGURE 4. A north-facing slope covered with "mud heads". Photograph courtesy of Clayton Kennedy.

temperature in sunny weather, it did not feel cold until later when a strong and gusty wind sprang up. I wore the jacket and liner in camp and during a two hour walk after the wind had risen. The combination was about right for the conditions.

The next day was windy, overcast and chilling cold, about 4 °C, with occasional spits of cold rain. I set out to check a portion of the valley wall near the camp wearing the Norwegian shirt, the Helly Hansen pile jacket liner with hood, the Dermoflex coated nylon jacket and combat trousers. I was surprised to find that the river in the big valley was down considerably despite the rainy weather. Not knowing if there would be another opportunity to examine a small valley on the other side I decided to take the current as it served, left a well-marked note, and crossed the river. This time the water did not rise above the top of the Goretex socks which had the velcro closure and my socks and insoles stayed dry. The combat boots, which had just dried out after the last time I crossed the river, got wet again. I explored parts of two valleys, which I have called "Return Creek" and "Patrol Creek"[1]. On Return Creek I noted a two metre wide coal seam. It was hot climbing hills and cool at some other times. For the first time, I carried the outer parka in my pack but used it only to cover my legs when I sat down for lunch. On the way back to camp I stopped while crossing the big river to wash the sand and mud off of my outer clothing while wearing it. It was a novel experience which proved the waterproofness of the fabric.

The next morning, July 20, started cold and grey. I decided to try a set of very thin, skin-tight underwear (Thermax) under my trousers. I had to wear my light boots, for the combat boots would be wet for at least another day. During breakfast it snowed and the wind made miniature snow drifts around the tents. We lingered in the camp for a while to see what the weather was going to do. When the sun came out at 9:30 AM., Dale Russell suggested we go for a "little walk". It was nice out with little wind so I started with the pile liner over the Norwegian terry shirt. That was too hot so I took the liner off. The shirt alone was too cool so I wore the jacket, open and over the rucksack, to encourage air circulation. This was cooler than the pile jacket liner, but I still sweated. Keeping up to Dale was usually difficult for he sets a fast and tireless pace. Not long after starting I regretted the decision to go with the underwear. The sweat-soaked, clinging material of the underwear was hot and irritating. Later, when we stopped for lunch, I put the pile liner back on under the jacket, but the sweat evaporating from the wet underwear and shirt chilled me into misery. The Sun had disappeared behind cloud cover and the wind had become strong. Dale's little walk stretched on and on. Eventually, we stopped heading away from camp and began to work our

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[1] These are provisional names. See reference 2.

way back over the hills paralleling the coast of Bay Fiord before dividing into groups to examine different areas.

On the way back to camp, I was delighted to witness the family life of the arctic hare, such as it is. The mother and leverets get together for only a few minutes to nurse, every nineteen hours or so before again dispersing over the hills (9). In this case there were five hares on a totally barren hilltop of dark gravel. The white dots slowly converged into a single mass. After a while, the mother sprang out the midst of the pushing, fighting mass of white and ran off at top speed; the little ones caught her but after a short struggle she was off again. Again they gave chase but soon gave up and went their separate ways. Phillip Currie caught up to me with the news that he had found an old campsite, marked by broken bone fragments and many wooden tent pegs.

On July 21 we prospected north of the camp. Phillip showed me the old camp site. There was little to see and only a practiced and observant eye would have noticed it in the first place. We separated, and I searched the bed of a creek flowing north towards Bay Fiord, finding no fossils but lots of green areas, coal seams and muskoxen. My right foot had improved significantly, but since I had lost the tape I began to develop blisters. That evening the batteries for the bear alarm were found to be dead. The alarm had operated for about one hundred hours and would probably have lasted longer had I not used the batteries to add some charge to a 6 volt rechargeable battery.

On July 22 we broke camp to move to the other side of the big valley to a larger lake at approximately 78° 48' N, 84° 18' W. While waiting for the helicopter I wore the outer parka for the first and only time, put on a second pair of trousers, wrapped my legs in the Space Blanket and went to sleep in the sunshine on a patch of willows. The air temperature was about 2 °C. A mosquito got into my parka hood and woke me with its buzzing after a short nap. As we flew out, it seemed to me that the bottom of the little lake was covered with clean sand. This seemed odd for there is no sand in the vicinity. I have since learned that algal mats have been found growing on the bottom of ice-covered lakes in Antarctica. Such a mat might have the given the lake bottom its sandy appearance. The new camp at the southwest corner of the larger lake was on a rather dismal brown plain rising to desolate hills that ringed the horizon (Fig. 5). A strong and chill wind that lifted the dust blew across the empty plain. Our little lake of wind-chimes at the last camp now seemed a delight by comparison. The cheerless aspect was somewhat relieved by the sunshine, blue water, white ice and by the cries of nesting birds. It wasn't nearly as depressing as the airport area at Resolute and after a couple of meals it became home.

Setting up the tent was only slightly complicated by the wind. Mine had a dozen or so places to attach guy lines for windy days.

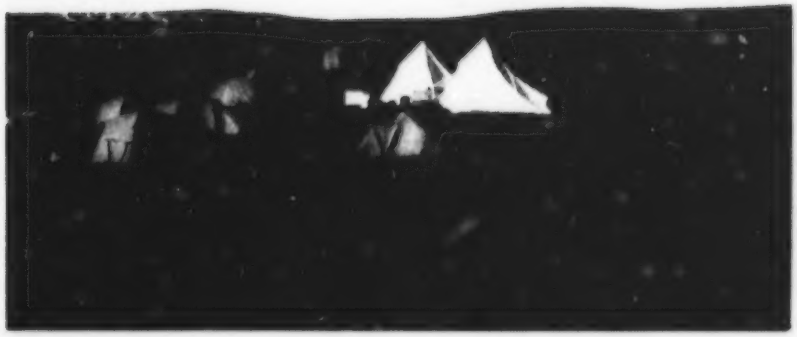

FIGURE 5. The camp on the windy plain, at about midnight. Note the thermometer tripods, anchored to rocks, to the right of the author's tent in the foreground.

The tabs which I didn't use flapped and snapped in the wind all night, disrupting my sleep. The tent structure creaked where the poles crossed, the vestibule rattled and the zipper pulls jingled. The Logan tents popped and boomed alarmingly in the gusts. Dust also filtered in to settle on the inner tent. By morning the wind had died. At 8 a.m. the temperature in the tent was up to 27 °C in the sunshine; the black thermometer read 10.5 °C, and at 5:30 p.m., it read 20 °C. The air temperature was around freezing in the morning and 6 °C in the afternoon.

I examined an area south of the camp and afterwards walked up Patrol Creek as far as I thought my feet would allow, which was almost to the plateau north of Trold Fiord. The creek was opaque, brown and undrinkable. All but two or three of the many little streams which emptied into it were also brown with sediment. I discovered that only those running through the rare patches of vegetation on the valley sides were clear. This suggests that the water might be cleaned by letting it run over a fibrous mat of some kind, although this might not work for rock flour from melting glaciers, for which the type of filter used to remove yeast cells from wine has been recommended (8). I carried a plastic canteen which I refilled from the clear brooks.

Because the morning was calm, I had put my jacket in my pack and had worn the pile liner over the Norwegian Army shirt. It was hot walking up the valley so I removed the pile liner, putting it on again just before lunch. On the way back, downhill and walking more slowly, I needed the jacket too. I had lunch in sunshine in a pass near a pinnacle of red rock, watched intently by a snowy owl. Later, I discovered it had a nest of fuzzy owlets on top of the rock tower. As on other days when it was sunny and I could find shelter from the wind, I removed my boots and socks during the lunch rest period to dry them and my feet. This time I had worn two wool socks on one foot and one wool over a polypropylene sock on the other but noticed no difference in the socks while walking, and no difference worth mentioning when I took them off then or later that evening. Shortly after lunch I turned back, walking downstream until I found the spot I had reached from the first camp several days before. I then turned and headed back to the lake.

It was still calm and sunny when I got back to camp. The tent was up to 37 °C but it didn't feel that warm because the radiant temperature of the shade side was low. The night was extraordinary, dead calm, with a clear blue sky. I recorded the temperatures at hourly intervals throughout the night as the Sun circled the sky. Because the tent door zippers made enough noise to wake every person within 50 metres, I left them open most of the night. It was quite amusing in the mornings to listen to the chorus of zippers as everyone got up; first the sleeping bags, then six inner door zippers opening and then closing, six outer door zippers opening and then closing, and each zip making a different sound. The tactical usefulness of these types of tents could be

limited by the noise made by the zippers on the openings. Despite open doors, few mosquitoes came into the tent. Many collected on the sunny side of the tent. Those that did come in were apparently looking for shelter, not a meal. Some muskoxen came close to the camp around midnight, but they were no problem either, being too big for the tent doorway and camera-shy.

The next day I headed out south and then east passing a kill site I had found on a previous day. Three muskox skeletons were strewn about a little knoll, some of the bones split for marrow. Humans had been here before, but when, was impossible to guess. Bone can lie out on top of the ground here for centuries without disintegrating. Farther on I made a long and careful examination of a couple of black hillsides but found only one bone which I thought might possibly be a fossil (it wasn't), marked the spot with a bit of flagging tape and moved on. I returned to camp after checking out an interesting area of sandstone pillars. A few days later, Dong Zhiming went to the area I had searched and came back with a rucksack full of plesiosaur parts which he told me he found only a few steps from my mark, in an area unmarked by my footprints. I began to suspect that the hills were concealing their treasures for those more worthy than I. Areas with footprints were not searched by other members of the expedition. Since I was not very efficient at finding fossils, I suspected that my well-intentioned searches might be a liability in that they marked off areas where there might still be fossil material which an expert could find.

Because the night had been both literally and figuratively "white", I called it a day early and was the first back to camp. Since it was warm, I decided to have a quick bath. This was a very dusty place, with fine black powder that filtered into the tent when the wind blew and ground itself in hands, faces, clothing and, of course, the shotgun. The night before, Richard Day had a quick dip in the lake between the muddy beach and the ice sheet that covered a good part of the lake. I did not consider that a particularly rational solution to the problem of bathing. Instead, I made a shallow tub in a hole in the ground that had been formed by the intersection of four deep frost cracks, lined it with the Space Blanket and heated 3 litres of water with which to shower with the aid of my plastic mug. I wasted no time, for my ablutions were witnessed by as thick a cloud of mosquitoes as I have ever seen. I needn't have hurried. The mosquitoes seemed more curious than hungry and didn't bite once. The temperature was about 10 °C but the sunshine and still air made it seem more like 20 °C.

The others, who had headed out north and west of the lake, returned to camp with bags of fossil material from plesiosaurs and mosasaurs and spread their treasures out for viewing and discussion. Mosquitoes swarmed onto any dark surface such as a black sweater, dark hair, etc, but didn't seem too interested in faces or hands which were exposed. They ignored my olive green

shirt and tan trousers. Mosquitoes were so numerous that some of the others put on headnets. Had the air temperature been a few degrees higher, these insects might have been a real problem.

I stayed close to Dong Zhiming and Dale Russell the next morning, learning what I could from the masters. They showed me the texture of rock in which fossils were being found and explained the stratigraphy. Zhiming then began pointing out bits of bone which had been invisible to my eyes and suggested where I might look for more. He was correct of course. I was amazed by his ability to spot tiny pieces of fossil bone from a distance of several metres. I came back to camp with Zhiming and spent the rest of the afternoon trying to improve the water supply.

At dinner the night before, Clayton Kennedy had brought the five gallon water pail into the tent and asked if anyone wanted to see his "aquarium". The water was alive with fairy shrimps and tubefex worms. I wondered what invisible things these creatures were eating. I didn't mind drinking them in coffee, which is boiled, but had avoided the Tang that morning. The others apparently didn't mind the presence of aliens in the orange drink; having recently spent months in the Gobi desert, they had probably had worse. I checked a couple of the little green ponds near the lake but they were no better. These little ponds seemed perfect for frogs, but of course there were none. Next I tried to dig a hole beside the lake so that the water would filter in through the soil. This didn't work because I hit the frostline at a depth of about 30 cm, about the same level as the water in the lake. In the end, I filtered the water through paper towels using a colander. Filters used for drip coffee might be a convenient way to clean the larger beasties out of the drinking water.

The frozen ground caused a small problem with the foam mats the others used under the sleeping bags for insulation and comfort. I used an insulated cot. The lower pad of open-cell polyurethane foam soaked up quite a bit of water. It was suspected that the tent floors were leaking water in some way. This is a natural conclusion, but not the correct one. Actually, it made no difference whether or not the floor was waterproof for the water came from the air in the tent or from the body while sleeping. The mats insulated the tent floor from the "heat" of the summer, allowing it to cool to a temperature near that of the permafrost layer a foot or so beneath. With an air temperature of about 10 °C, the relative humidity even on dry, clear days had been between 50% and 60%, so that the dew point was around 2 °C. The dew point would have been higher in an occupied tent in which there might be wet clothing. The water vapour in the air would diffuse into the foam mats and condense in the colder parts against the floor. Buildings use vapour barriers on the warm side to prevent a similar problem from occurring. The cot, which did not touch the floor, stayed dry. It is possible, if not likely, that the base of a pile of stores on permafrost might become wet under a waterproof tarp by

similarly condensing water out of the air.

The knowledge of where large fossils might be found prompted me to return to the valley of Patrol Creek the next day. I had become convinced that the fossil skeleton seen over seventy years before had been somewhere in that valley but my earlier search had proven that it was no longer as obvious as it once had been. Now I could focus my search to two exposures of one rock formation. One of these places was particularly attractive for it was close to the valley floor. I took three large freezer bags to cover my boots for I knew that I would be forced to cross the creek several times, and my light hiking boots which were not waterproof. The bags fit into a pocket conveniently and were easily donned. The third bag was a container for the other two after they became wet and muddy. Eventually the bags developed holes, but the idea of lightweight, external "fording socks" might have some merit. Inexpensive polyethylene bags made to fit over boots can be purchased from safety supply companies. These are only "3-mil" plastic, however.

I searched the place where I hoped to find some trace of the lost fossil skeleton that had brought us to Ellesmere Island and collected some pieces of rock which I suspected might be fossil bone. Much later, back at camp, my suspicions were confirmed. They were parts of a plesiosaur. Finding this spot had been my goal on this expedition. I was only a little disappointed that there was so little of the creature left, for judging from the erosion of this part of the valley, I had been lucky to find anything. Phillip Currie had correctly predicted that there would be little or nothing left after such a long time.

Only one other small valley had even a slight possibility of being the one in which the 1926 skeleton had been found and for completeness, I decided to check it that afternoon after making a short side trip to explore an intriguing box canyon. I climbed a hill on the way to the stream which I wanted to inspect hoping that the earlier travellers, who recorded climbing a high hill near their camp at the confluence of Patrol Creek and the wide valley, might have left some record of their passage. It didn't look particularly high, but this time the distance/scale illusion was reversed for it was much bigger than it looked. There was no trace that anyone had ever been on the windy hill top before. The other side was easy walking and I soon reached the little valley and followed it up to a point I had visited before, stopping for tea in a patch of Cassiope tetragona, where there was a clear brook. In the High Arctic, Cassiope tetragona grows where the snow drifts last into the summer. To find it under the snow in winter, one must be able to recognize such places.

The water in the little brook was clear and cold, with melting snowdrifts not far away. The stream came from the direction of camp so I followed it. A few paces upstream, I came to the end of

the vegetation and the water became turbid and brown. Low areas are often not the easiest place to walk for the frost makes mudheads grow where there is water in the soil. These can be anything from the size of a grapefruit to the size of a kitchen table. One must step directly on the top for otherwise there is a chance that they will tip or that your foot will slip off. Nearing the lake, I flushed a flock of snowgeese out of some small ponds. They can't fly at this time of year and set off running and flapping. The little ones did surprisingly well at keeping up over the mudheads. No wonder polar bears don't usually bother trying to catch them. In sight of the camp I stopped for another cup of tea and a granola bar, regretting now the side trip to the canyon. I often used heather for fuel when making tea, but just as often I used a fuel pellet of the type which used to be included in the Canadian Forces rations, and sometimes both.

The next day was the last day of prospecting. I decided to make the ninety minute trek back to the site on Patrol Creek to look for more bone. I didn't find any, but located the fragmented remains of a very large spherical concretion which may have been connected to the legend, for the lost "fossil monster" was supposed to have been found near a "strange round mound". On the way back to camp I passed through a most desolate landscape, resembling an Apollo landing site. It was warm and windy with bright sunshine; about 12 °C when I returned to camp at 4:30 p.m.

The helicopter was due the next day and accordingly the weather changed in the night to rain with wind. By morning it was near freezing. Low cloud to the west threatened to delay our lift out. Waiting for the helicopter was uncomfortably cool despite the intermittant sunshine, wearing the jacket, liner and trousers. We kept one Logan tent up for shelter from the brisk wind. At about 4 p.m. the helicopter arrived to take us back to Strathcona Fiord, the first leg of a long trip home. Dinner that evening just off the "strip" at the Fossil Forest River was a meal of odds and ends: boil-in-bag lasagna and rigatoni, a couple of cans of Klick, hot Chinese garlic, curry, black pepper and a box of instant mashed potatoes. It was all cooked in the same big pot and it was devoured to the last scrap. It was just as well that the potatoes were mixed with the rest of the food, for the water here was also brown with sediment. Although we all had a few turns at cooking, Richard Day and Clayton Kennedy most often added this task to their professional duties. We ate like lumberjacks and were often still hungry. Clayton's experiments with such delights as frying pan peanut butter pie had whetted our appetites for the huge butter tarts, apple crumble and other desserts remembered fondly from our stay at the PCSP base in Resolute.

It rained all night and the next morning. The only reasonable way to pass the time was to sleep. A large aircraft flew over in the afternoon, heading south. I wondered whose it might be, for it wasn't connected to the operations of PCSP. Each of the many small

scientific parties which PCSP supports throughout the Arctic is in contact with Resolute by radio twice a day. Such a network might be used to report any such overflights in future to determine if Canadian airspace is used without Canadian knowledge or to help locate a missing aircraft. Since these field parties report weather information for the Department of the Environment twice daily, it would be a simple matter to ask them to report any unusual aircraft movements. Each field party listens to the twice daily scheduled reports of the other stations and is aware of scheduled PCSP flights in its vicinity.

The mountains had acquired a new covering of snow overnight. Winter had never seemed far away and now it seemed distinctly closer. By 5:30 p.m. we were airborne and on the way back south. A C130 Hercules was getting ready for takeoff when we landed at Resolute. Possibly it was the aircraft we had heard passing overhead, for our camp had been on a direct line between Alert and Resolute. We were booked into the new PCSP residence building for a couple of days while awaiting a commercial flight south. Although the accommodations were very comfortable, I did not sleep much that first night. It was too hot in the sleeping bag and too cool without it, dogs whined outside and cars and gravel trucks drove past along the gravel road.

My impression of the Resolute area was reinforced after a walk down to the sea, along the beach and back up via a barren ravine. No gravel on this route, but limestone, shattered by frost into sharp angular pieces that forced a slow walk. A wheeled vehicle might have difficulty on this loose surface. The head of the ravine was somewhat more interesting with stone stripes and stone circles, however, the day's highlights continued to be the meals in the PCSP dining room.

Our flight south left the next afternoon, making a short stop in Iqaluit. On the way to Montreal, I watched the Sun set for the first time in almost a month.

SOLAR RADIATION AND WET COLD

The month of July in the High Arctic had been a lot like October or early November in southern parts of Canada. The terrain was uniquely polar however, as was the twenty-four hour daylight. Although the temperature varied only from about 0 °C to about 10 °C, comfort varied more widely, being influenced more by wind speed and sunshine than by temperature.

An attempt was made to measure the effect of low angle arctic sunshine on a vertical surface by setting up two thermometers on camera tripods at each camp. These thermometers were tapped into cylinders of aluminum which were 7.5 cm in diameter by 16.5 cm in height. The two cylinders differed in their emissivity and

reflectivity and were designed to have approximately the same surface area as a human face. Half of the area is always in shade and the rest exposed to the Sun at the full range of angles. Since a face, a roughly vertical surface, is usually oriented randomly with respect to the Sun, half of the time it is in shade and the rest of the time exposed to it at a range of angles from full-on to perpendicular. Each cylinder thus approximated a face which has a changing orientation. The face is the most exposed part of the body. With it, we sense the environment most acutely, indeed, the senses are concentrated there. The face senses first whether a day is hot, humid, cold or windy. Face temperature has been shown to influence the sensation of whole body comfort (10). Radiant heating of the face increases peripheral circulation (11), resulting in higher skin temperatures and greater thermal comfort.

At noon on July 24, the Sun was 31° above the horizon and at midnight, 9°. As the Sun gets lower, its light is increasingly attenuated by the greater thickness of the atmosphere through which it must pass; at the same time however, it shines more directly on a vertical face. The net effect was a reduction in the temperature increment of the absorbing cylinder thermometer from 15 °C which had been achieved in the morning or late afternoon to 11 °C after midnight. This suggests a net reduction in the solar heat input of about 30% at midnight, which explains the lingering snowdrifts on the north-facing slopes. Unfortunately no readings were possible at midday. In low wind conditions the low-angle sunshine of the Arctic added about 15 °C to the temperature of a partly illuminated absorbing vertical surface. It can be assumed that sunshine must also have a significant effect on the surface temperature of a human face. By extension, the low-angle sunshine of Fall and Winter in more southern latitudes can be expected to have a similar effect. We probably need look no further to explain the phenomenon of the sensation of wet-cold. Heat loss from a body is not higher in humid air than in dry air at the same temperature. However, when it is cool and humid, it is often cloudy. A chilling, "wet-cold" day, is a day that feels colder than expected. The warming effect of solar radiation on the face and body is much reduced by cloud cover. The sensation of wet-cold is a result of the lack of sunshine.

At any time of day, sunshine raised temperatures in tents by many degrees, greatly enhancing comfort. A maximum temperature increment of 30 °C was noted in the upper regions of the tent. This not only made life more comfortable, but made it possible to dry clothing. Some effort should be devoted to optimizing this effect in the design of a small tent for cold weather use. Obviously this effect should be minimized in tents for hot conditions. My small tent would have been unbearably hot on a more temperate plain.

CLOTHING SYSTEM PERFORMANCE

The clothing system design proved to have unexpected flexiblity (Fig. 6). The original concept called for the jacket liner to be used only as a supplement in extreme cold conditions. In cold wet conditions the parka was to be added over the jacketshell when more insulation was required during period of low activity (12). However, even while active, there were times when more than just the shells was needed. It was more convenient to wear the jacket liner, which might be better described as a pile sweater, than to wear the bulky outer parka. The pile liner could be worn under the jacket in windy or cloudy weather or when not expending much energy, without the jacket on sunny days or cloudy days when there was little wind but work rates were high, in camp and even while sleeping. It was not inconvenient to add or remove this layer in the open for, unlike the winter, the arctic summer was never so stressful that the jacket could not be removed briefly. The coated trousers were too warm to wear on sunny days with little wind when I wore instead some heavy cotton trousers. I could have added the Dermoflex coated combat trousers over these if the weather changed, especially if the wind came up, but only once did I carry the extra pair of trousers. Changes in heat production were frequent but a little sweat in the clothing was not a problem except when close fitting underwear was worn. Layers that wick are layers that get wet. Thin, tight-fitting inner layers add little to the insulation but retain water; they are uncomfortable when sweating and cold later.

The only wear appeared at the inner seams of the trouser legs near the cuffs where holes formed at the edge of the seam sealing tape. The commercial Goretex trousers had a wear patch in this location. Holes also formed in the inside of pockets. I found bits of dinosaur bone in the lining of the pant cuffs when I got home. A water repellent finish on the outside of the shells and outer parka would keep the clothing cleaner and reduce the heat loss which occurs when the wet shells are dried by body heat. I didn't like the positioning of the belt loops at the front or the design of the front zipper on the trousers; it should not start at the waist band. The sizing of both the jacket and the trousers seemed to be too generous. These are minor points which will be worked out as the design continues to evolve.

The one occasion on which I carried the outer parka was a particularly chilly day, overcast with wind. It was comforting to know that the extra insulation was available in the event of an injury while alone or if an increase in the river flow made it impossible to return to camp for a few hours. I think that if I had to remain in one place for an indefinite period of time, I would have found the outer parka a very useful item. As it was, when I got cold I could simply get up and continue my explorations, rewarming with exercise. In the week long trial on Baffin Island in 1988 (13), outer parkas were worn on several occasions, usually

FIGURE 6. The author in prototype clothing at Strathcona Fiord.

while stationary. They were worn on one cold day while walking downhill at a reduced pace because of a minor injury to one of the personnel. Outer parkas were always carried because they moved their camp almost every day. The usefulness of the outer parka on a wet-cold exercise will vary with the kinds of activities carried out. The other members of the 1989 expedition successfully used commercial clothing; Goretex shells, pile jackets, sweaters, jogging suits, long underwear, blue jeans.

Most of my problems were related to footwear, which leaked and caused blisters. There is room here for improvement. Boots should probably not be insulated for the insulation inevitably gets wet and takes days to dry if it cannot be removed and replaced. As leather also soaks up a lot of water it should only be used where a less hydrophilic material will not do the job. A boot like the jungle/desert boot with a removeable waterproof but vapour-permeable sock or lining with an elastic top, might be a good combination. Replaceable felt insoles, which could be worn inside the waterpoof sock should be considered, especially if they could be made of a wicking synthetic material which might dry more quickly than the standard wool felt ones. The mesh insoles do not provide enough cushioning and would abrade a waterproof lining or sock. The key to preventing trench foot in combat situations is regular foot maintenance. Feet would probably be better looked after if footwear were more conveniently removable. Lacing is secure but it is time-consuming.

CONCLUSION

In winter in the Arctic, the cold is often painful, sometimes indescribably so. There are also times when the cold is a dull but deep, persistent ache. This expedition, although it took place in summer, was not exempt from this latter kind of cold discomfort, especially in camp on windy, cloudy days. Fortunately, it could be banished by exercise, a hot meal or a good sleeping bag. Life in these condition was no picnic (for one thing, there weren't any ants). Although it was sometimes uncomfortable, with reasonable clothing which was windproof, waterproof and somewhat permeable to water vapour and with a decent sleeping bag and shelter from wind and rain at the camp, it was never really dangerous. In uncomfortable weather, attractive goals are necessary to ensure that equipment and personnel get a realistic test (14). The possibility that the lost fossil skeleton might still be found drove me to stay out longer in demanding weather than I might otherwise have desired. It pushed me up and down dozens of hillsides that I would not otherwise have dreamed of scaling and forced me to walk a hundred miles on feet that complained bitterly. Feet have so little imagination.

Over the last two hundred years or so, the far corners of the Earth have been investigated by explorers from many nations.

Many of these people were scientists, trained in subjects ranging from Anthropology to Zoology. Because clothing and shelters are of paramount importance in stressful environments, many have been moved to comment on these subjects, although few, if any, have had much grasp of the physics or physiology of protection. The published accounts of their experiences in the Earth's less comfortable places constitute a large body of subjective impressions and observation which can be prospected for bits of information relevent to environmental protection and defence operations in general. Theoretical knowledge combined with first-hand experience of stressful environments is essential to the proper understanding of such subjective information. No environment can be so minutely described that a reader could predict its every interaction with personnel. A second-hand knowledge of an environment creates a fragmentary image which lacks depth and colour. Regardless of how much reading and study one has done in preparation, to experience an alien environment first-hand is to know it for the first time.

Many of the technical problems associated with attempting to do science in the arctic winter while part of a more or less mobile force or field party were not factors in this expedition. The relatively fixed camps and warm weather would have permitted more elaborate measurements than those which were carried out. Despite this, useful information and experience was obtained. Any future field trips to the Arctic in the spring and summer seasons would benefit from coordination with PCSP. The Polar Continental Shelf Project, Energy Mines and Resources Canada, runs a first-class operation in the Arctic coordinating the logistics of over two hundred scientific field parties a year. Not only would its support be useful for future scientific efforts of the Environmental Protection Section, but the corporate experience of this organization and the network of field parties that it supports could be valuable resources for other defence operations in the area.

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